Improving the Environmental Performance of U.S. Laboratories

by

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Abstract

The U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) have launched a new, voluntary initiative to improve the environmental performance of U.S. laboratories. The Laboratories for the 21st Century (Labs21) initiative is focusing on improving the energy efficiency of the nation's laboratories. As laboratory energy efficiency improves, Labs21 will focus on even more aggressive pollution prevention goals and strategies unique to each type of laboratory.

Using the Labs21 approach, EPA and DOE estimate that laboratories can decrease energy consumption by 60 to 75 percent. EPA applied the Labs21 approach to an existing EPA laboratory and is expecting to reduce its annual electric demand by 68 percent and its utility costs by almost 75 percent. Assuming that only 25 percent of U.S. laboratories achieve a 60 percent reduction in energy consumption, the United States could reduce its annual energy consumption by 84 trillion Btus, which is equal to the energy consumed by 840,000 U.S. households. An efficiency improvement of this magnitude would save $1.25 billion annually.

In addition to the cost savings, the environmental benefits of the potential energy savings also are significant. Conserving 84 trillion Btus of energy would decrease carbon dioxide (CO_2) emissions by 19 million tons, which is equivalent to removing 1.3 million automobiles from U.S. highways or preserving 56 million trees from harvest. Reducing CO_2 emissions can help alleviate potential human-influenced, adverse effects on the global climate.

For additional information on Labs21, please visit <www.epa.gov/labs21century> or call Phil Wirdzek with EPA at 202 564-2040.

Improving the Environmental Performance of U.S. Laboratories

The U.S. Environmental Protection Agency (EPA) and U.S. Department of Energy (DOE) recently launched "Laboratories for the 21st Century" (Labs21), a voluntary initiative to improve the environmental performance of U.S. laboratories. Although the initiative is still in its formative stages, it focuses on improving laboratory energy- and water-efficiency. As the Labs21 energy- and water-efficiency focus gains wider acceptance, the Labs21 initiative will evolve to include even more aggressive pollution prevention goals and strategies unique to laboratory facilities.

The primary guiding principle of the Labs21 energy- and water focus is that improving the energy efficiency and environmental performance of a laboratory requires examining the entire facility from a holistic, or comprehensive, perspective. Adopting this perspective allows laboratory designers, operators, and owners to improve the efficiency of the entire facility rather than improving the efficiency of specific laboratory building components. As Labs21 practitioners understand, improving the efficiency of individual components without examining their relation to the entire system can eliminate opportunities to make other more significant efficiency improvements.

As currently envisioned, Labs21 will focus on the following five activities:

- Creating a national database of current environmental practices, including energy and water consumption data for a variety of laboratory types. The data can be used to compare laboratory performance.
- Negotiating voluntary goals for laboratory environmental performance, including energy and water efficiency goals, with each potential Labs21 participant.
- Providing training or other opportunities to exchange technical information.
- Establishing partnerships with interested Labs21 participants.
- Promoting the Labs21 initiative.

Benefits of Labs21

According to EPA estimates, if only 25 percent of the nation's estimated 150,000 private and public research laboratories achieve energy-efficiency improvements of 60 percent (an efficiency gain less than that expected from efficiency projects being conducted in EPA facilities), then the United States could reduce its annual energy consumption by 84 trillion Btus, which is equal to the energy consumed by 840,000 U.S. households. This would save $1.25 billion in utility costs, reduce carbon dioxide emissions by 19 million tons, and remove the equivalent of 1.25 million automobiles from U.S. highways.

Other benefits of the Labs21 approach include:

- Lower laboratory utility and operating costs
- Reduced health and safety risks
- Improved facility management
- Reduced greenhouse gas emissions
- Elimination of waste and other inefficiencies
- Improved community relations
- Lower insurance premiums

Why Focus on Laboratories?

The typical laboratory currently uses five times as much energy and water per square-foot as the typical office building due to intensive ventilation requirements and other health and safety concerns. Examining energy and water requirements from the holistic building perspective promoted by Labs21, however, can identify significant opportunities to improve efficiencies while continuing to meet or exceed health and safety standards.

EPA has implemented other programs designed to help reduce pollution by promoting energy and water efficiency. Energy Star <www.epa.gov/energystar> and Climate Wise <www.epa.gov/ climatewise>

both promote energy efficiency as a way of improving environmental performance. In addition, the WAVE program <www.epa.gov/owm/genwave.htm> addresses water efficiency. These programs have incredible promise and provide very useful information, but they do not addresses the specific needs of laboratories. Labs21 will focus exclusively on laboratory facilities.

EPA's Experience

EPA has adopted the Labs21 perspective for its facilities and is anticipating some significant cost savings and environmental benefits as a result. For example, EPA's 150,000 square-foot National Vehicle and Fuel Emissions Laboratory in Ann Arbor, Michigan, has required 2.5 megawatts of electricity, consumed energy at a rate exceeding 700,000 Btus per gross-square-foot, and consumed 31 million gallons of water annually at a cost to the taxpayers of more than a million dollars a year. EPA is implementing mechanical modifications at the facility that are guaranteed to:

- Reduce annual electrical demand by 68 percent.
- Reduce energy use per gross-square-foot by 66 percent.
- Reduce annual water consumption by 80 percent.
- Reduce the annual utility bill by 74 percent (for a savings of more than $800 thousand a year).
- Provide a simple payback on the contractor's capital expenditure of less than 10 years.

Based on the expected successes of this project, EPA is retrofitting several other laboratories with very different user profiles, energy costs, and meteorological conditions and is predicting comparable savings.

Why Focus on Energy Efficiency?

Many people express concerns that these facilities are operationally unique. That they are designed to minimize and eliminate employee health and safety risks, to use building components that have existed in the industry for years, and to reduce any variables that might compromise the research or data being developed in the facility. Such thinking unfortunately is interpreted to mean that the facility or energy system designs are better off left untouched with regard to aggressive energy efficiency.

However, the labs21 initiative believes it is these very reasons that require new thinking in laboratory energy systems and laboratory designs. The Labs21 proposes that there is an important beneficial link between energy efficiency, environmental protection and operational integrity.

Every day, 15 million tons of carbon dioxide (CO_2) is added to the Earth's atmosphere due to human activities. Ice core samples indicate that since the dawn of the industrial revolution, atmospheric CO_2 concentrations have increased by 30 percent. Many scientists are concluding that these emissions are already adversely affecting the global climate.

If these conclusions are accurate, decreasing CO_2 emissions becomes an important global priority and improving energy efficiency becomes an important way to reduce CO_2 emissions. Of the 15 million tons of CO_2 emitted each day, electricity generation is one of the largest emissions sources. Approximately 2.3 pounds of CO_2 is produced for every kilowatt-hour of electricity generated. Improving energy efficiency or switching to renewable energy can significantly reduce CO_2 emissions.

By improving energy efficiency, Labs21 can help reduce energy consumption, protect the environment, save money, apply the monetary savings to additional scientific research, and most importantly help drive market pool for energy efficient and renewable energy building technologies and building concepts. Improving energy efficiency, to use the current catch-phrase, is a win-win-win solution.

Efficiency Upgrades

The strategy to improve energy efficiency and water conservation in laboratory facilities has several key inter-relatable components: energy efficient equipment, cogeneration, distributed power, thermal storage and recovery, and renewable energy systems. These components can be planned into existing laboratory retrofits or new laboratory facilities using an engineering approach which integrates their operations, including energy inputs and outputs, to optimize the performance of each component through a highly automated level of computerized management. Under such an approach, EPA believes its mantra to reduce, reuse and recycle can be applied to energy streams in facility operations.

This approach is the central theme to EPA's Energy Star Buildings program which addresses commercial office spaces. However, the Department of Energy's Lawrence Berkeley National laboratory (LBNL) has followed a similar pathway in developing its Laboratory Design Guide.

The LBNL guide, *A Design Guide for Energy-Efficient Research Laboratories*, is intended to assist facility owners, architects, engineers, designers, facility managers, and utility demand-side management specialists in identifying and applying advanced energy-efficiency features in laboratory-type environments. The Guide focuses comprehensively on laboratory energy design issues with a "systems" design approach. Although a laboratory-type facility includes many sub-system designs, e.g., the heating system, LBNL believes that a comprehensive design approach should view the entire building as the essential "system." This means the larger, macro energy-efficiency considerations during architectural programming come before the smaller, micro component selection such as an energy-efficient fan. LBNL encourages readers to consider the following three points when utilizing the Guide.

1) Since the Guide's design recommendations focus upon energy efficiency, it is best used in conjunction with other design resources, manuals, handbooks, and guides. The Guide is not meant to supplant these resources but rather to augment them by facilitating the integration of energy-efficiency considerations into an overall design process.

2) Though the Guide may seem to push the envelope of traditional engineering design practice, its recommendations are widely used in actual installations in the United States and abroad. LBNL believes

that successful design teams build from the members' combined experience and feedback from previous work. Each team should incorporate energy efficiency improvements, as appropriate, by considering their interactions and life-cycle costs. LBNL recognizes that there is no single design solution for all situations; thus, the Guide focuses on conceptual approaches rather than prescriptive measures.

3) LBNL has performed an extensive literature search and present brief excerpts from many excellent publications. LBNL encourage readers to obtain the full citation of interesting and pertinent documents.

Unfortunately, this approach is not the norm for laboratory building systems' designs. Typically, these designs defer to the concerns noted earlier. With such thinking, EPA believes a very significant opportunity to advance energy technologies in the marketplace could be postponed aggravating the countries continued dependence on foreign and polluting fuels.

EPA believes that because most laboratories are not speculative buildings, they present investment opportunities that extend beyond those of commercial buildings. Laboratory ownership is expected to be more stable. Consequently, life-cycle decisions and investment periods can more easily accommodate these buildings' expected useful life. Capital investments in laboratories could support a simple payback of 10 or more years as opposed to 3 or 4 years for office buildings. Under such ownership conditions and investment environments, the application of the Labs21 approach to laboratory energy efficiency and water conservation can be financially feasible.

Financing Efficiency Upgrades

When renovating its Ann Arbor, MI., laboratory, EPA used an Energy Savings Performance Contract (ESPC), a third party financing technique, to finance the capital improvements because the agency did not have the available appropriations to pay for aggressive energy efficiency improvements at this facility. Using the ESPC approach, EPA and other federal government agencies can finance dramatic efficiency improvements in their laboratories with the energy-related savings generated by the energy efficient capital improvement. With the Ann Arbor ESPC, a private-sector contractor (NORESCO) agreed to pay for all of the necessary upgrades (approximately $10 million), provide a guaranteed efficiency

improvement of 66 percent, and provide complete operations, maintenance and replacement of the equipment throughout the life of the contract. In exchange, EPA will provide payment to NORESCO from the energy and water efficiency savings for 23 years.

Similar financing opportunities are available to private sector laboratories via the services of an Energy Savings Contractor (ESCO), utility contracts, and other third party financing mechanisms. Like an ESPC, ESCOs and utility companies agree to finance energy- and water-efficiency improvements in exchange for a portion of the resulting savings. Regardless of the third party financing scenario, EPA believes the ownership conditions and investment environment are capable of generating aggressive energy efficiency and water conservation results.

Future Views

EPA also believes that the laboratory energy efficiency investments come at a time when changes and flexibility in the nation's power industry and the demand for power will permit technology applications to spread more rapidly. In this business environment, aggressive utility corporations will find new avenues for services and revenues and develop partnerships that produce a broader spectrum of benefits. The opportunity for emissions trading opens new visions for business as well. Efficiency improvements and distributed power generation at laboratory facilities may provide significant financial incentives to further off-set investment costs associated with the Labs21 approach.

Finally, EPA is hoping to connect the Labs21 Initiative with its Project XL program. Under Project XL, EPA provides regulatory relief to target industry sectors. Project XL, which stands for "eXcellence and Leadership," is a national pilot program that tests innovative ways of achieving better and more cost-effective public health and environmental protection. Through site-specific agreements with project sponsors, EPA is gathering data and project experience that will help the Agency redesign current approaches to public health and environmental protection. Under Project XL, sponsors -- private facilities, multiple facilities, industry sectors, Federal facilities, communities, and states -- can implement innovative strategies that produce superior environmental performance, provide flexibility, cost savings, paperwork reduction or other benefits to sponsors, and promote greater accountability to stakeholders. Project XL has

committed to a scope of fifty pilot projects. Because of its limited scope, it is vital that each project tests new ideas with the potential for wide application and broad environmental benefits. As of September 1999, fourteen pilot experiments are being implemented, and thirty-one other project ideas are being developed or negotiated. EPA is pursuing the Labs21 Initiative in this regard and will provide updates on this opportunity on the Labs21 website (www.epa.gov/labs21century). Information on Project XL can be found at <www.epa.gov/projectxl>.

Labs21 Conference

Individuals interested in the Labs21 initiative are encouraged to attend the upcoming Labs21 conference to be held in California, Fall 2000. The conference planning committee is currently accepting abstracts from potential speakers. Abstracts are due by June 30, 2000. For additional information on the conference, including a preliminary agenda and information on submitting an abstract, please visit the Labs21 Web site at <www.epa.gov/labs21century>.

For Additional Information

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